The CRUSHED STONE JOURNAL

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SILVER ANNIVERSARY CONVENTION

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NATIONAL CRUSHED STONE ASSOCIATION

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

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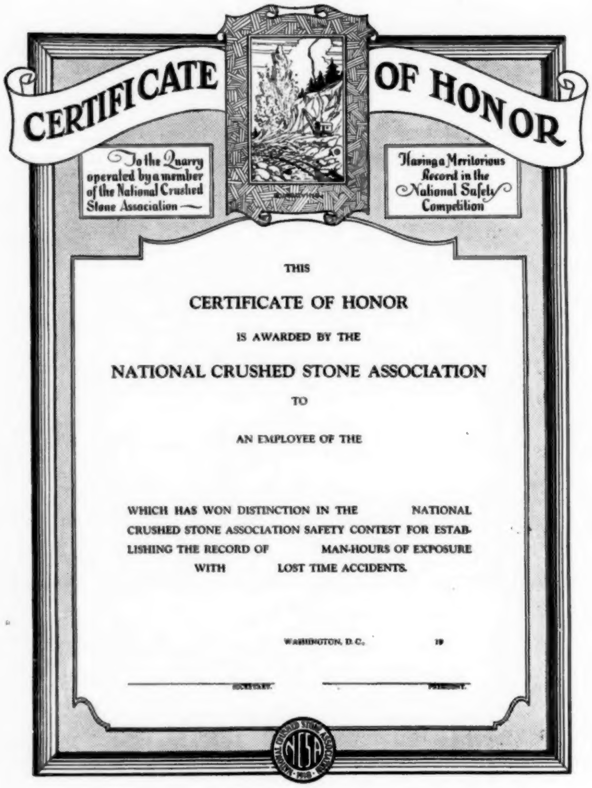

CERTIFICATE OF HONOR

To the Quarry operated by a member of the National Crushed Stone Association —

Having a Meritorious Record in the National Safety Competition

THIS

CERTIFICATE OF HONOR

IS AWARDED BY THE

NATIONAL CRUSHED STONE ASSOCIATION

TO

AN EMPLOYEE OF THE

WHICH HAS WON DISTINCTION IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY CONTEST FOR ESTABLISHING THE RECORD OF MAN-HOURS OF EXPOSURE WITH LOST TIME ACCIDENTS.

WASHINGTON, D.C., 19

SECRETARY. PRESIDENT.

THIS Certificate of Honor will be presented to each employee of each plant which completed the year 1940 with no lost time accidents.

THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XVI No. 4 JULY-AUGUST, 1941

The National Crushed Stone Association Safety Competition of 1940

By T. D. LAWRENCE and
J. E. ISAACSON

Under Supervision of W. W. Adams, Employment Statistics Section, Mineral Production and Economics Division, U. S. Bureau of Mines.

• Blairs granite quarry of the South Carolina Granite Company, a division of the Southern Aggregates Corporation wins NCSA Safety Contest. Honorable mention given 18 plants for accident-free record.

A FIFTEEN per cent reduction in the accident-severity rate at crushed stone plants was revealed by reports from companies that participated in the safety contest of 1940 conducted by the Bureau of Mines, United States Department of the Interior, in cooperation with the National Crushed Stone Association. The contest of 1940 was the 15th yearly safety competition conducted by the Bureau of Mines for the promotion of safety in the crushed stone industry. Forty-six open quarries and four underground mines, all members of the National Crushed Stone Association, were enrolled in the contest. The enrolled companies competed for a safety trophy, a bronze plaque on which is portrayed in bas-relief the quarry scene on the pedestal of the "Sentinels of Safety" trophy awarded in the National Safety Competition, furnished by the *Explosives Engineer* magazine for annual award to the company that establishes the best accident-prevention record in the contest.

The winner of the 1940 award was the Blairs granite quarry, Blairs, Fairfield County, S. C. This quarry was operated by the South Carolina Granite Company, a division of the Southern Aggregates Corporation, and worked 142,386 man-hours without a disabling injury.

Each plant, except the winner, that operated throughout the contest year without a lost-time injury was awarded honorable mention and is to be presented with a parchment reproduction of the *Explosives Engineer* award. In addition, each employee of the winning plant and of the plants receiving honorable mention is presented with a certificate of honor. The 18 plants receiving honorable mention were:

1. Glen Mills trap-rock quarry, Glen Mills, Delaware County, Pa., operated by The General Crushed Stone Company, worked 133,959 man-hours.

2. Margerum limestone quarry, Margerum, Colbert County, Ala., operated by the Alabama Asphaltic Limestone Company, worked 114,267 man-hours.

3. North American limestone quarry, Security (near Hagerstown), Washington County, Md., operated by the North American Cement Corporation, worked 100,866 man-hours.

4. Watertown limestone quarry, Watertown, Jefferson County, N. Y., operated by The General Crushed Stone Company, worked 90,773 man-hours.

TABLE 1

RELATIVE STANDING OF QUARRIES IN THE 1940 NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, BASED UPON THE ACCIDENT-SEVERITY RATES OF THE QUARRIES[1]

Code No.	Group No.	Man-hours worked	Number of injuries[2]					Average days of disability per temp. injury	Number of days of disability[2]					Frequency rate[3]	Severity rate[3]
			F.	P.T.	P.P.	Temp.	Total		F.	P.T.	P.P.	Temp.	Total		
1	1	142,386	—	—	—	—	—	—	—	—	—	—	—	0.000	0.000
2	2	133,959	—	—	—	—	—	—	—	—	—	—	—	.000	.000
3	3	114,267	—	—	—	—	—	—	—	—	—	—	—	.000	.000
4	4	100,866	—	—	—	—	—	—	—	—	—	—	—	.000	.000
5	5	90,773	—	—	—	—	—	—	—	—	—	—	—	.000	.000
6	6	75,061	—	—	—	—	—	—	—	—	—	—	—	.000	.000
7	7	72,636	—	—	—	—	—	—	—	—	—	—	—	.000	.000
8	8	71,646	—	—	—	—	—	—	—	—	—	—	—	.000	.000
9	9	71,282	—	—	—	—	—	—	—	—	—	—	—	.000	.000
10	10	69,106	—	—	—	—	—	—	—	—	—	—	—	.000	.000
11	11	62,684	—	—	—	—	—	—	—	—	—	—	—	.000	.000
12	12	53,945	—	—	—	—	—	—	—	—	—	—	—	.000	.000
13	13	53,151	—	—	—	—	—	—	—	—	—	—	—	.000	.000
14	14	50,132	—	—	—	—	—	—	—	—	—	—	—	.000	.000
15	15	48,879	—	—	—	—	—	—	—	—	—	—	—	.000	.000
16	16	45,434	—	—	—	—	—	—	—	—	—	—	—	.000	.000
17	17	18,510	—	—	—	—	—	—	—	—	—	—	—	.000	.000
18	18	16,619	—	—	—	—	—	—	—	—	—	—	—	.000	.000
19	19	15,147	—	—	—	—	—	—	—	—	—	—	—	.000	.000
20	20	61,961	—	—	—	1	1	12	—	—	—	12	12	16.139	.194
22	21	106,713	—	—	—	1	1	27	—	—	—	27	27	9.371	.253
23	22	504,081	—	—	—	3	3	67	—	—	—	201	201	5.951	.399
24	23	55,561	—	—	—	1	1	36	—	—	—	36	36	17.998	.643
25	24	98,645	—	—	—	6	6	11	—	—	—	66	66	60.824	.669
26	25	172,298	—	—	—	3	3	41	—	—	—	123	123	17.412	.714
27	26	187,746	—	—	—	1	1	135	—	—	—	135	135	5.326	.719
28	27	174,443	—	—	—	2	2	65	—	—	—	130	130	11.465	.745
29	28	62,176	—	—	—	3	3	16	—	—	—	49	49	48.250	.788
30	29	54,700	—	—	—	1	1	46	—	—	—	46	46	18.282	.841
31	30	184,610	—	—	—	3	3	53	—	—	—	159	159	16.250	.861
32	31	106,650	—	—	—	6	6	17	—	—	—	99	99	56.259	.928
33	32	67,670	—	—	—	1	1	65	—	—	—	65	65	14.778	.961
34	33	47,778	—	—	—	3	3	17	—	—	—	50	50	62.790	1.047
35	34	143,358	—	—	—	7	7	22	—	—	—	157	157	48.829	1.095
36	35	71,530	—	—	—	1	1	84	—	—	—	84	84	13.980	1.174
37	36	105,172	—	—	—	7	7	20	—	—	—	143	143	66.558	1.360
38	37	47,434	—	—	—	4	4	21	—	—	—	83	83	84.328	1.750
39	38	32,022	—	—	—	1	1	71	—	—	—	71	71	31.229	2.217
40	39	7,816	—	—	—	1	1	22	—	—	—	22	22	127.943	2.815
41	40	194,208	—	—	1	—	1	—	—	—	600	—	600	5.149	3.089
42	41	186,421	—	—	—	9	9	65	—	—	—	585	585	48.278	3.133
43	42	29,264	—	—	—	5	5	19	—	—	—	93	93	170.858	3.178
46	43	32,491	—	—	—	1	1	231	—	—	—	231	231	30.778	7.110
47	44	80,662	—	—	1	4	5	8	—	—	600	32	632	61.987	7.835
48	45	61,641	—	—	1	1	2	192	—	—	300	192	492	32.446	7.981
49	46	174,720	1	—	2	2	5	61	6,000	—	1,050	122	7,172	28.617	41.049
Totals and rates, 1940		4,358,409	1	0	5	78	84	39	6,000	0	2,550	3,013	11,563	19.273	2.653
Totals and rates, 1939		4,219,086	2	0	2	51	55	33	12,000	0	4,800	1,678	18,478	13.036	4.380

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the plants to which this table relates are not revealed

[2] F., fatal; P.T., permanent total disability; P.P., permanent partial disability; Temp., temporary disability.

[3] Frequency rate indicates the number of fatal, permanent, and other disabling injuries per million man-hours of exposure; severity rate indicates number of days of disability lost from injuries per thousand man-hours.

TABLE 2

RELATIVE STANDING OF UNDERGROUND MINES IN THE 1940 NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, BASED UPON THE ACCIDENT-SEVERITY RATES OF THE MINES[1]

Code No.	Group No.	Man-hours worked	Number of injuries[2] F.	P.T.	P.P.	Temp.	Total	Average days of disability per temp. injury	Number of days of disability[2] F.	P.T.	P.P.	Temp.	Total	Frequency rate[3]	Severity rate[3]
21	1	121,329	—	—	—	1	1	29	—	—	—	29	29	8.242	0.239
44	2	121,830	—	—	—	2	2	210	—	—	—	419	419	16.416	3.439
45	3	72,761	—	—	—	4	4	95	—	—	—	381	381	54.975	5.236
50	4	60,067	—	—	1	1	2	59	—	—	4,500	59	4,559	33.296	75.899
Totals and rates, 1940		375,987	0	0	1	8	9	111	0	0	4,500	888	5,388	23.937	14.330
Totals and rates, 1939		393,039	0	0	1	7	8	65	0	0	600	457	1,057	20.354	2.689

[1] As reports from mining companies are considered confidential by the Bureau of Mines, the identities of the plants to which this table relates are not revealed.

[2] F., fatal; P.T., permanent total disability; P.P., permanent partial disability; Temp., temporary disability.

[3] Frequency rate indicates the number of fatal, permanent, and other lost-time injuries per million man-hours of exposure; severity rate indicates number of days of disability lost from injuries per thousand man-hours.

5. Cedar Hollow limestone quarry, Devault, Chester County, Pa., operated by the Warner Company, worked 75,061 man-hours.

6. White Haven sandstone quarry, White Haven, Luzerne County, Pa., operated by The General Crushed Stone Company, worked 72,686 man-hours.

7. Oglesby limestone quarry, Oglesby, La Salle County, Ill., operated by the Marquette Cement Mfg. Company, worked 71,646 man-hours.

8. LeRoy limestone quarry, LeRoy, Genesee County, N. Y., operated by The General Crushed Stone Company, worked 71,282 man-hours.

TABLE 3

YEARLY SUMMARY—OPEN QUARRIES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926-40

Year	Plants	Man-hours worked	Number of injuries[1] Fatal	P.T.	P.P.	Temp.	Total	Number of days of disability[1] Fatal	P.T.	P.P.	Temp.	Total	Frequency rate[2]	Severity rate[2]
1925[3]	38	4,927,402	4	——	3	292	299	24,000	——	3,600	5,286	32,886	60.681	6.674
1926	40	5,298,983	3	——	6	207	216	18,000	——	9,000	4,239	31,239	40.763	5.895
1927	48	7,876,791	9	——	2	458	469	54,000	——	2,100	7,186	63,286	59.542	8.034
1928	53	7,509,098	8	——	4	322	334	48,000	——	8,700	5,493	62,193	44.479	8.282
1929	53	7,970,325	4	——	5	286	295	24,000	——	5,760	5,533	35,293	37.012	4.428
1930	68	8,013,415	6	——	9	227	242	36,000	——	7,250	3,671	46,921	30.199	5.855
1931	58	5,085,857	4	——	13	198	215	24,000	——	18,660	3,540	46,200	42.274	9.084
1932	40	2,661,850	1	——	4	75	80	6,000	——	6,750	2,481	15,231	30.054	5.722
1933	40	2,704,871	1	——	1	67	68	6,000	——	48	2,893	8,941	25.510	3.306
1934	46	3,288,257	1	——	2	106	109	6,000	——	2,850	1,873	10,723	33.148	3.261
1935	46	4,166,306	2	1	8	77	88	12,000	6,000	9,900	3,015	30,915	21.122	7.420
1936	50	6,399,023	5	——	14	182	201	30,000	——	8,168	4,590	42,758	31.411	6.682
1937	47	6,199,001	7	——	9	136	152	42,000	——	5,875	4,461	52,336	24.520	8.443
1938	47	4,658,119	2	——	6	76	84	12,000	——	6,600	3,184	21,784	18.033	4.677
1939	44	4,219,086	2	——	2	51	55	12,000	——	4,800	1,678	18,478	13.036	4.380
1940	46	4,358,409	1	——	5	78	84	6,000	——	2,550	3,013	11,563	19.273	2.653
Total 1926-40	—	80,409,391	56	1	90	2,546	2,693	336,000	6,000	99,011	56,850	497,861	33.491	6.192
Total 1925-40	—	85,336,793	60	1	93	2,838	2,992	360,000	6,000	102,611	62,136	530,747	35.061	6.219

[1] P.T., permanent total disability; P.P., permanent partial disability; and Temp., temporary disability.

[2] Frequency rate indicates number of fatal, permanent, and other lost-time injuries per million man-hours of exposure; severity rate indicates number of days of disability from injuries per thousand man-hours.

[3] The National Crushed Stone Association Safety Competition began in 1926; figures for 1925 for company members are given for comparison.

TABLE 4

YEARLY SUMMARY—UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926-40

			Number of injuries [1]					Number of days of disability [1]						
Year	Plants	Man-hours worked	Fatal	P.T.	P.P.	Temp.	Total	Fatal	P.T.	P.P.	Temp.	Total	Frequency rate [2]	Severity rate [2]
1925[3]	3	400,672	—	—	—	29	29	—	—	—	228	228	72.378	0.569
1926	3	517,926	—	—	—	34	34	—	—	—	533	533	65.646	1.029
1927	2	318,449	1	—	1	14	16	6,000	—	300	68	6,368	50.244	19.997
1928	5	542,193	1	—	1	68	70	6,000	—	300	888	7,188	129.105	13.257
1929	4	665,520	1	—	1	30	32	6,000	—	300	617	6,917	48.083	10.393
1930	6	595,367	1	—	1	15	17	6,000	—	225	468	6,693	28.554	11.242
1931	3	345,105	—	—	—	4	4	—	—	—	147	147	11.591	.426
1932	2	158,450	—	—	—	6	6	—	—	—	165	165	37.867	1.041
1933	3	229,381	—	—	—	11	11	—	—	—	349	349	47.955	1.521
1934	4	248,146	—	—	—	13	13	—	—	—	287	287	52.389	1.157
1935	2	175,994	—	—	—	3	3	—	—	—	249	249	17.046	1.415
1936	4	334,747	1	—	—	7	8	6,000	—	—	117	6,117	23.899	18.274
1937	3	364,680	—	—	—	3	3	—	—	—	91	91	8.226	.250
1938	3	334,442	—	—	—	2	2	—	—	—	133	133	5.980	.398
1939	4	393,039	—	—	1	7	8	—	—	600	457	1,057	20.354	2.689
1940	4	375,987	—	—	1	8	9	—	—	4,500	888	5,388	23.737	14.330
Total 1926-40	—	5,599,406	5	0	6	225	236	30,000	0	6,225	5,457	41,682	42.147	7.444
Total 1925-40	—	6,000,098	5	0	6	254	265	30,000	0	6,225	5,685	41,910	44.166	6.985

[1] P.T., permanent total disability; P.P., permanent partial disability; and Temp., temporary disability.

[2] Frequency rate indicates number of fatal, permanent, and other lost-time injuries per million man-hours of exposure; severity rate indicates number of days of disability from injuries per thousand man-hours.

[3] The National Crushed Stone Association Safety Competition began in 1926; figures for 1925 for company members are given for comparison.

TABLE 5

YEARLY SUMMARY—OPEN QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION, 1926-40

			Number of injuries [1]					Number of days of disability [1]						
Year	Plants	Man-hours worked	Fatal	P.T.	P.P.	Temp.	Total	Fatal	P.T.	P.P.	Temp.	Total	Frequency rate [2]	Severity rate [2]
1925[3]	41	5,328,074	4	—	3	321	328	24,000	—	3,600	5,514	33,114	61.561	6.215
1926	43	5,816,909	3	—	6	241	250	18,000	—	9,000	4,772	31,772	42.978	5.462
1927	50	8,195,240	10	—	3	472	485	60,000	—	2,400	7,254	69,654	59.181	8.499
1928	58	8,051,291	9	—	5	390	404	54,000	—	9,000	6,381	69,381	50.178	8.617
1929	57	8,635,845	5	—	6	316	327	30,000	—	6,060	6,150	42,210	37.865	4.888
1930	74	8,608,782	7	—	10	242	259	42,000	—	7,475	4,139	53,614	30.086	6.228
1931	61	5,430,962	4	—	13	202	219	24,000	—	18,660	3,687	46,347	40.324	8.534
1932	42	2,820,300	1	—	4	81	86	6,000	—	6,750	2,646	15,396	30.493	5.459
1933	43	2,934,252	1	—	1	78	80	6,000	—	48	3,242	9,290	27.264	3.166
1934	50	3,536,403	1	—	2	119	122	6,000	—	2,850	2,160	11,010	34.498	3.113
1935	48	4,342,300	2	1	8	80	91	12,000	6,000	9,900	3,264	31,164	20.957	7.177
1936	54	6,733,770	6	—	14	189	209	36,000	—	8,168	4,707	48,875	31.038	7.258
1937	50	6,563,681	7	—	9	139	155	42,000	—	5,875	4,552	52,427	23.615	7.987
1938	50	4,992,561	2	—	6	78	86	12,000	—	6,600	3,317	21,917	17.226	4.390
1939	48	4,612,125	2	—	3	58	63	12,000	—	5,400	2,135	19,535	13.660	4.236
1940	50	4,734,396	1	—	6	86	93	6,000	—	7,050	3,901	16,951	19.643	3.580
Total 1926-40	—	86,008,817	61	1	96	2,771	2,929	366,000	6,000	105,236	62,307	539,543	34.055	6.273
Total 1925-40	—	91,336,891	65	1	99	3,092	3,257	390,000	6,000	108,836	67,821	572,657	35.659	6.270

[1] P.T., permanent total disability; P.P., permanent partial disability; and Temp., temporary disability.

[2] Frequency rate indicates number of fatal, permanent, and other lost-time injuries per million man-hours of exposure; severity rate indicates number of days of disability from injuries per thousand man-hours.

[3] The National Crushed Stone Association Safety Competition began in 1926; figures for 1925 for company members are given for comparison.

9. Earlham limestone quarry, Earlham, Madison County, Ia., operated by the Marquette Cement Mfg. Company, worked 69,106 man-hours.

10. Marquette limestone quarry, Cape Girardeau, Cape Girardeau County, Mo., operated by the Marquette Cement Mfg. Company, worked 62,684 man-hours.

11. Jordanville limestone quarry, Jordanville, Herkimer County, N. Y., operated by The General Crushed Stone Company, worked 53,945 man-hours.

12. No. 4 trap-rock quarry, Plainville, Hartford County, Conn., operated by The New Haven Trap Rock Company, worked 53,151 man-hours.

13. Union Furnace limestone quarry, Tyrone, Huntingdon County, Pa., operated by the American Lime and Stone Company, worked 50,182 man-hours.

14. No. 1 trap-rock quarry, East Wallingford, New Haven County, Conn., operated by The New Haven Trap Rock Company, worked 48,879 man-hours.

15. North American limestone quarry, Alsen (near Catskill), Greene County, N. Y., operated by the North American Cement Corporation, worked 45,484 man-hours.

16. Reidsville granite quarry, Reidsville, Rockingham County, N. C., operated by the Southern Aggregates Corporation, worked 18,510 man-hours.

17. No. 6 trap-rock quarry, Cheshire, New Haven County, Conn., operated by The New Haven Trap Rock Company, worked 16,619 man-hours.

18. North American limestone quarry, Howes Cave, Schoharie County, N. Y., operated by the North American Cement Corporation, worked 15,147 man-hours.

TABLE 6

NUMBER OF INJURIES BY CAUSES AT QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION IN 1940.

Cause	Fatal	Permanent Total	Permanent Partial	Temporary	Total
Falls and slides of rock	—	—	—	8	8
Handling materials and rock	—	—	—	6	6
Hand tools	—	—	1	11	12
Explosives	—	—	1	—	1
Haulage	—	—	—	8	8
Falls of persons	1	—	1	13	15
Bumping against objects	—	—	—	3	3
Falling objects	—	—	—	6	6
Flying objects	—	—	—	1	1
Electricity	—	—	—	1	1
Drilling	—	—	—	1	1
Machinery	—	—	3	8	11
Stepping on nail	—	—	—	—	—
Burns	—	—	—	1	1
Other causes	—	—	—	—	—
Not stated	—	—	—	19	19
Total	1	0	6	86	93

The following 20 States were represented in the contest:

Alabama	New York
California	North Carolina
Connecticut	Ohio
Georgia	Oklahoma
Iowa	Pennsylvania
Illinois	South Carolina
Maryland	Tennessee
Massachusetts	Texas
Michigan	Virginia
Missouri	West Virginia

The 46 open quarries operated 4,358,409 man-hours, a slight increase over 1939. The 1940 accident-severity rate of 2.653, the lowest since the contests have been conducted, was 39 per cent below the 1939 rate of 4.380. The accident-frequency rate increased from 13.036 in 1939 to 19.273 in 1940.

(Continued on page 25)

EMPLOYEES OF THE BLAIR'S GRANITE QUARRY OF THE SOUTH CAROLINA GRANITE CO., BLAIR'S, FAIRFIELD COUNTY, SOUTH CAROLINA, WINNER OF THE N. C. S. A. SAFETY CONTEST FOR 1940.

CHARLES M. DOOLITTLE

1876-1941

★

The Crushed Stone Industry in the United States, as well as in Canada, is saddened and grieved by the sudden death of Charles M. Doolittle. Immediately prior to his passing he had seemed to be in exceptionally good health but on Saturday morning, July 5, he did not feel sufficiently well to go to his office though his condition was not regarded as in the least serious. His death that same afternoon therefore was most unexpected.

Mr. Doolittle was born in Painsville, Ohio, and when he was but three years old was taken by his parents to Hamilton, Ontario, where he lived throughout his life. His father and uncle were associated with the Ontario Rolling Mill Company and were two of the founders of the Steel Company of Canada. His boyhood education was received in the Hamilton Public Schools as well as at Deveux College, Niagara Falls, N. Y. Later he attended Queen's University, graduating in mining engineering in 1904.

From early manhood, throughout his life, he modestly and unostentatiously associated himself with the civic betterment and improvement of Hamilton. He actively participated in the executive direction not only of those interests which sought to improve civic life but also in the athletic activities of the community. Only a week before his death he was elected President of the Hamilton Health Association. He ardently supported the Curling Club and the Football Club of the community. He was a past director of the Canada Good Roads Association, past chairman of the Hamilton Club, a member of the art committee of McMaster University, a trustee of Dale Community Centre, and was associated in various capacities with manufacturers' associations and chambers of commerce. He was a devout member of the Church of the Ascension, which he regularly attended with his family and in which he served for many years as a warden.

In Canada, Mr. Doolittle was a pioneer in the crushed stone industry and his company is now one of the largest in that country. Cut limestone from his Queenston Quarry has entered into the building of structures all over Canada and was even shipped to London, England, for use in the construction of the Ontario Government Building there.

Those of us in the United States came to know him best through our work with him in the National Crushed Stone Association. He was one of its few founders in 1917 and gave to it constantly from then on his faith and belief in association work. He was elected a director shortly after the Association was formed, a position which he held until his death. For some years he was a member of the executive committee and regional vice-president for Canada. Two of the annual conventions of the Association were held in Canada, one in Toronto and the other in Montreal, and on both occasions those who had the pleasure of attending will never forget the warm hospitality of Mr. Doolittle to his friends from the United States. In fact the convention in Montreal, in retrospect, seems to have centered around his modest and lovable personality. He was an able and wise counselor in the affairs of the Association, but even more than that shall we remember him for his sterling character and the lovable qualities of his nature.

We can well understand how the City of Hamilton and his family will mourn his loss and remember his goodly deeds, for we too shall miss him keenly. We will ever hold him in our thoughts with grateful recollection of the service he rendered our Association and time will not dim our affectionate regard for those qualities of character which endeared him to all of us.

To his friends in Canada, as well as to those on this side of the border and to his business associates, we extend our sincerest sympathy, but more particularly to the members of his family do we offer our heartfelt understanding of their loss.

Gradation of Mineral Aggregates in Dense Graded Bituminous Mixtures

By F. N. HVEEM

Senior Physical Testing Engineer,
Materials and Research Department,
California Division of Highways.

• The question of the most favorable gradation of aggregates is one which long has interested engineers having to do with pavement mixtures of various kinds, including bituminous as well as Portland cement concrete. Mr. Hveem's long experience with this general subject is evidenced in his informative discussion in the following article.

THE use of mineral aggregates and soils in engineering works presents many problems due to variations in these materials. While physical and chemical differences are important, and have been much investigated, this paper will be confined to a discussion of particle size distribution of the granulometric composition and its effect on the design of mixtures.

The need for sieve analyses and grading studies is rather self-evident and the procedures involved are familiar to most engineers. However, it may be of interest to outline briefly some of the factors which lead to a study of aggregate gradations in California and to comment on some of the trends and relationships which came to light.

Mixtures of bitumen and mineral aggregate have been used since ancient times and bituminous pavements are by no means new. However, from time to time the same old combinations of asphalt and mineral aggregate have a rebirth under a new name usually with a real or implied modification in some element or proportion. When the first oil mix road in California was built in 1926 it was generally regarded as something new and distinctly different from earlier types of bituminous pavements and attracted considerable attention because it appeared at a time when the need for low cost road surfacing was becoming acute. Today this type of surface covers many miles of rural highways.

Many Detailed Studies

Wide-spread use of the oil mix type of surfacing has not been free from trouble and our present knowledge of the process has resulted from a great deal of study and research on the part of numerous highway departments. In common with other States, California is more or less continually investigating and attempting to improve design methods and testing procedures in order to assure satisfactory construction.

Since the first report by McKesson and Frickstad in 1927, detailed studies have been under way including among other things, an investigation of the possible influence of aggregate gradation. In 1929 there were a number of oil mix sections already in use ranging from good to poor. The main idea at that time was to find out why certain sections were behaving well and why others were showing considerable distress despite the fact that they had been constructed under the same specifications and apparently under the same conditions. We were well equipped for the study with a full quota of preconceived opinions and ingrained notions among which was the belief that the principles of aggregate gradation had been well expounded and we were more or less prepared to find that many of the troubles on oil mix roads could be accounted for by improper grading of the aggregate. However, when a series of samples taken from good and bad sections were analyzed, it was a little disturbing to discover that some of the most unconventional and irregular grading curves were identified with the most sucessful roads, while in several failures, the gradings complied very nicely with orthodox ideas as represented by Fuller's curve.

Discovery Upsets Theories

This discovery was something of a shock and tended to destroy faith in "well known principles." We could not escape the conclusion that a satisfactory bituminous surface could be constructed almost without regard to aggregate gradations if the bitumen content was adjusted for the particular aggregate and gradation. It was evident that this optimum bitumen content had no consistent relationship to the void volume except that it was always less than the amount required to fill the voids. Against this conclusion was the fact that virtually all construction men are concerned with "good grading" and with "poor grading" and even though it was evident that the "principles of grading" must be quite elastic, the possibility still existed that there might be an "ideal grading."

Fig. 1

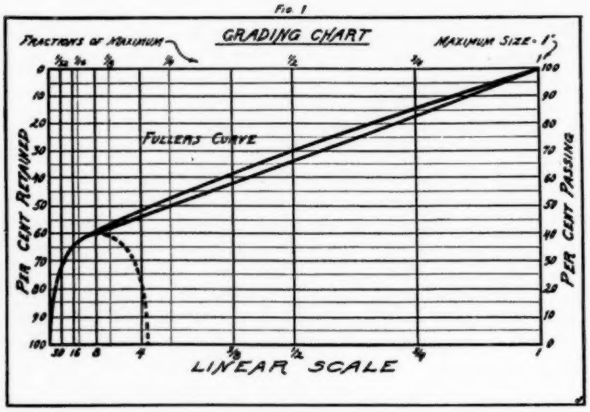


Fig. 2

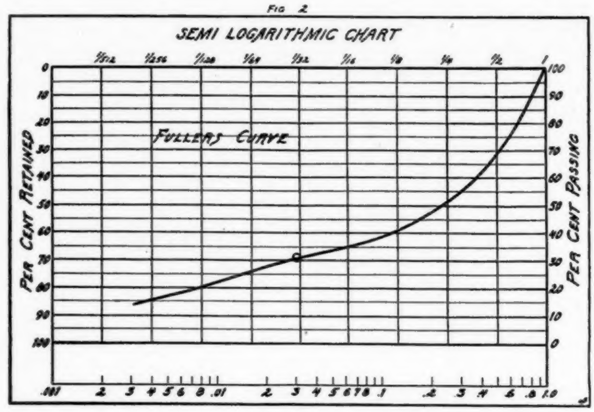


Fig. 3

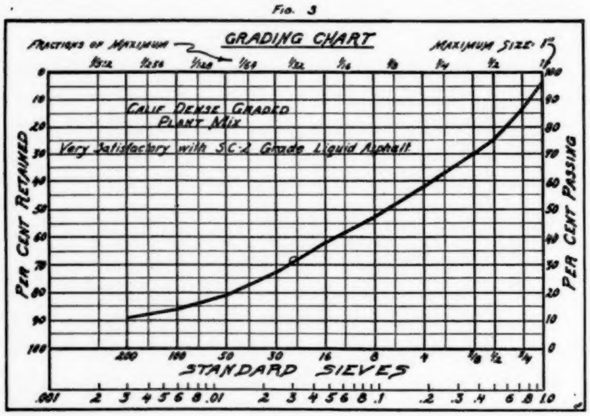


Fig. 4

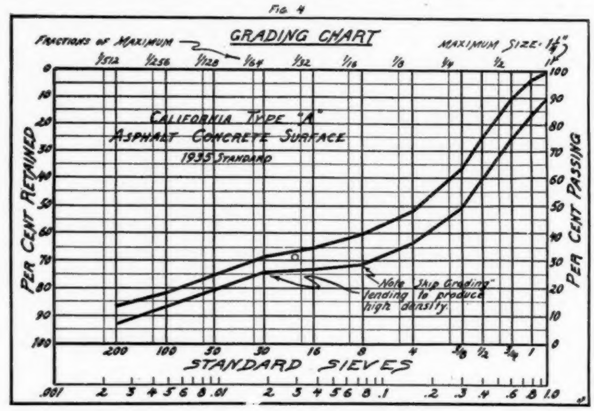


Fig. 5

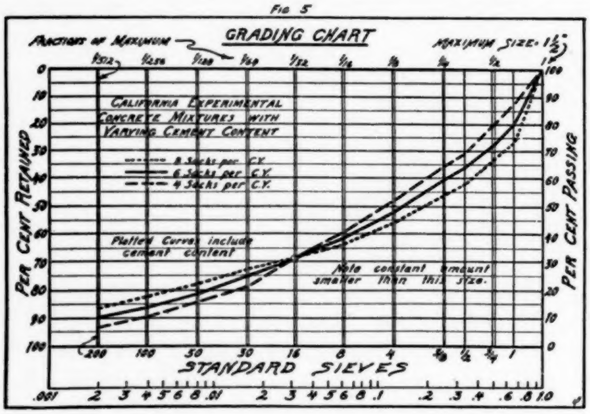
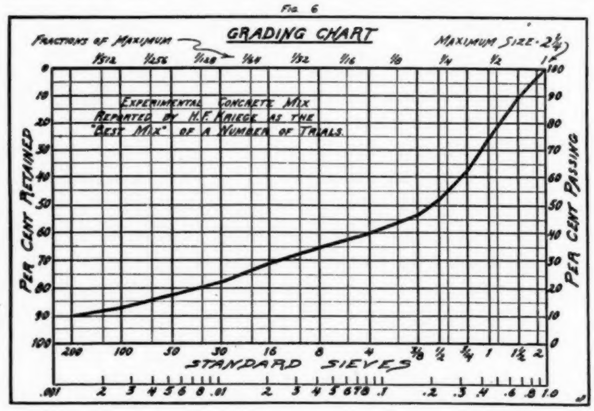


Fig. 6



Therefore, the first step was to compare gradings of various mixtures for the purpose of discovering any common properties or similarities which might exist.

In order to cover as broad a field as possible, portland cement concrete gradings were included in the study as well as gradings of bituminous mixtures. As these gradings covered a wide range of sizes, it was necessary to prepare grading charts which would permit comparison on a relative scale. This brought up the question as to the type of chart and the scales to be used.

Fuller's Curve

Figure No. 1 shows a simple linear scale on which Fuller's curve has been drawn. Fuller's curve as you

know, has the form of an ellipse on the finer portion of the curve and has been projected either as a curve or straight line from the vertical axis of the ellipse to the upper right hand corner of the chart. The linear scale for the sieve sizes is not very satisfactory because the lines in the sand sizes are too crowded for definition. A better type of chart is the semilogarithmic type shown on Figure No. 2. The abscissa value or the screen sizes on the logarithmic chart give good definition throughout the entire range. Fuller's curve is shown transferred to the semilogarithmic chart.

The following figures, No. 3 to 9, will show the results obtained by platting the grading curves of previously existing construction which for the most part, represents gradings that resulted from long study or experimentation on the part of several individuals responsible.

Figure No. 3 shows the grading of a plant mix surfacing in California from one of the most satisfactory jobs constructed prior to 1930. All material is smaller than 1 inch.

Figure No. 4 is Type "A" Asphaltic Concrete surface used in California for a number of years past. Material passes 1¼ inches.

Figure No. 5 is a series of three gradations of portland cement concrete using aggregate below ½ inch, with three percentages of cement. The three mixes were part of a laboratory experiment aimed at securing similar workability and water cement ratios with the varying cement contents. It should be noted that for comparison portland cement concrete mixtures are platted with the cement content included with the aggregate. You will note that the three gradations developed experimentally tend to intersect at a point represented by 31 per cent of the vertical scale and at a size equal to .031 on the abscissa scale. This point will be referred to later.

Figure No. 6 represents a grading of portland cement concrete developed by Professor H. F. Kriege and reported in Rock Products. All aggregate was smaller than 2¼ inches maximum.

Figure No. 7 is the "best grading" developed in our own laboratory for Portland cement concrete with a certain type of crushed rock at 2½ inches maximum.

Figure No. 8 is paving concrete with 3½ inches maximum stone and Figure No. 9 is paving concrete using 4 inches maximum stone.

Different Experiments

I would again like to repeat that all of these gradations were developed by different individuals working independently and separated by considerable distance and time, and each one represents the most ideal combination which was developed after a great many trials and consideration of other combinations. These figures by no means represent all of the material studied. Each is somewhat typical of the particular size group. *In passing I might call attention to the fact that regardless of individual variations in coarse and fine aggregate all of these most satisfactory gradings tend to pass close to the point represented by the co-ordinates, 31 per cent of the material passing a size equal to .031 of the particular maximum size of the gradation.* This prevailing common type or pattern of grading seems to be too consistent to be accidental and has been used to establish grading charts which have been made the basis for the design of bituminous paving mixtures. These charts shown herewith, indicate tolerance limits which are, in effect, a rationalization of data similar to that just shown.

Figure No. 10 is a so-called general grading chart showing the slope of the curve from maximum to minimum with the abscissa values drawn as relative sizes only.

Figure No. 11 is the same type of curve on which the abscissa values represent actual sieves as they would appear for a grading ranging from 1 inch to dust. Having thus arrived at smooth attractive looking curves, through the simple expedient of ignoring those cases which did not conform, it may be well to offer some explanation which would help to show why this uniform type of grading will often be more satisfactory than other curves.

Maximum Density

Figure No. 12 is a collection of aggregate gradings which have been proposed, tried, or, in some cases, used with considerable success. I would like to point out the heavy shaded line which, from Professor Kriege's report may be taken as the ultimate in maximum density. Professor Kriege stated that if 50 per cent of the coarsest size was combined with 50 per cent of the finest material, the *resulting density would be greater than that of any other combination of sizes within the maximum and minimum limits.* It appears then, that any virtue in the type of grading shown on Figure No. 11, is due to the avoidance of certain difficulties more or less inherent in other patterns of gradation. These liabilities or hazards are set forth on the figure in the form of brief notes indicating possible or probable results should the grading curve go beyond the tolerance limits in the area of the chart covered by the notation.

Fig. 7

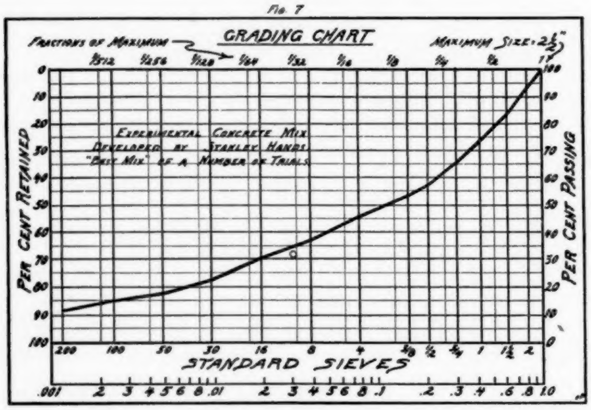


Fig. 8

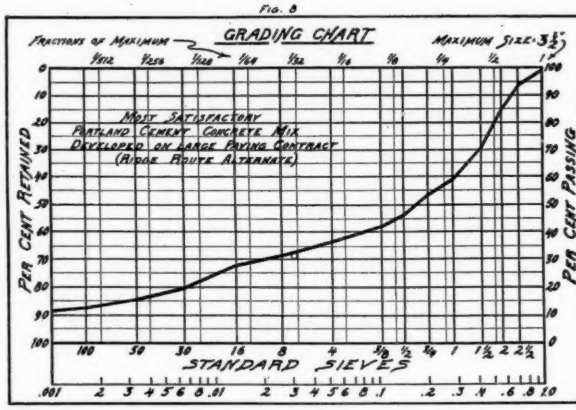


Fig. 9

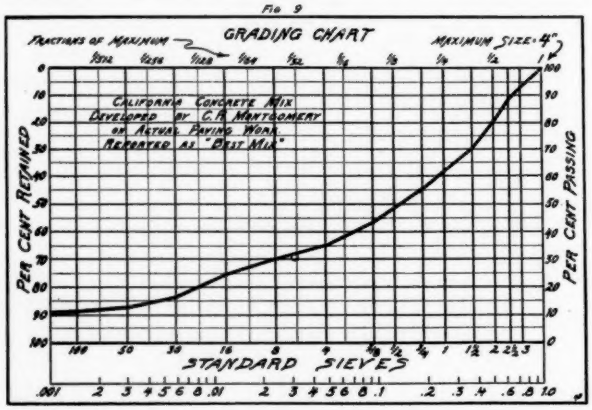


Fig. 10

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

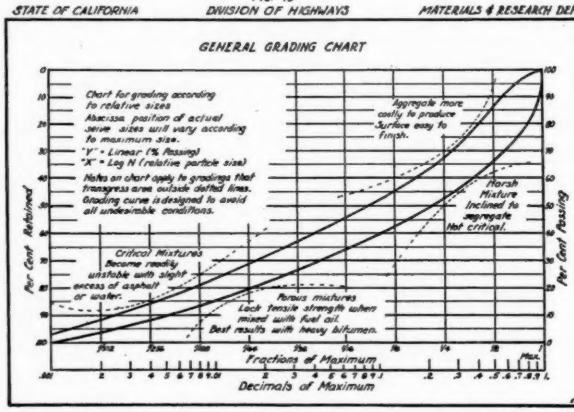


Fig. 11

STATE OF CALIFORNIA DIVISION OF HIGHWAYS MATERIALS & RESEARCH DEPT.

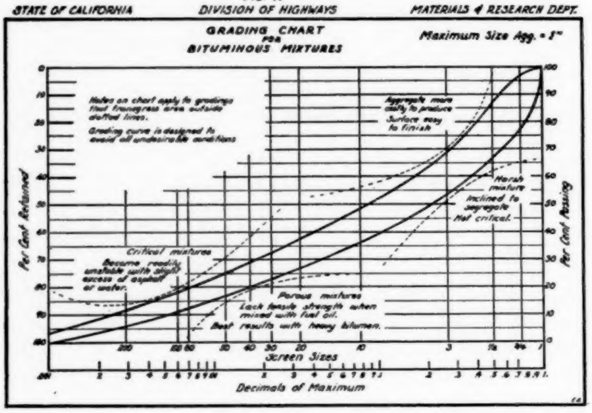
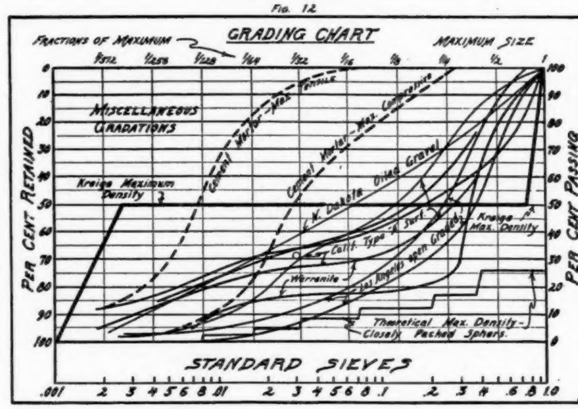


Fig. 12



However, these notations are an over-simplification. For example, on Figure No. 13 the hypothetical grading shown is deficient in fine sand. A grading of this type will ordinarily be porous and may or may not be undesirable depending on local conditions.

Figure No. 14, shows a distinctly different type of grading which is caused by an excessive amount of sand between the 30 and 100 mesh size. This type of curve is typical of a mixture containing wind blown sand. Our experience has shown that such mixtures are usually low in stability and are often permeable as well.

Ideal Grading

As a result of this study it was possible to assign a few reasons why a grading curve should have some particular or peculiar characteristics. It appears that there are a number of factors which may be affected by the gradation and also several *which are not.* It is necessary for the designer to distinguish and isolate the separate individual items and properties which are needed to accomplish the purposes of a particular project. It is also *necessary to know which of the essential properties depend on and are affected by the aggregate gradation.* With this information and knowledge, it is possible to develop an ideal grading for a specific purpose and from that to determine how nearly the ideal grading can be achieved with the aggregate available. Thus, the basic requirements and conditions can be stated rather briefly but it is not always a simple matter to arrive at a practical solution because in practice, the best grading that can be secured is usually a compromise.

As the word "compromise" implies recognition and allowance for the demands of several diverse elements, it is now necessary to describe some of the factors which may affect the choice of gradings. One of the first and desirable properties of mixtures are the qualities of plasticity and mobility which are usually grouped under the heading of workability. Hydraulic concrete, bituminous mixtures, and stabilized soils all must be workable; the degree required *depends on the conditions of use and type of equipment.*

Workability Important

Workability is usually of greater importance in portland cement concrete than in bituminous mixtures; nevertheless, it is one common requirement which is affected by gradation.

Another property influenced by grading is permeability. The importance of this property depends almost entirely on the type of structure. (A distinction should be made between permeability and density. The terms are not synonymous.) In paving mixtures it may be important that they be tight and relatively impermeable under conditions where it is necessary that a vulnerable subgrade be protected from the entrance of surface water through the pavement. It is often true, however, that the greatest danger of subgrade saturation comes from capillary moisture and a tight paving surface which restricts evaporation will frequently promote failure through an accumulation of moisture in a plastic subgrade. It has been demonstrated that a surface mixture with the proper degree of porosity will permit the subgrade to maintain a stable equilibrium by allowing moisture to evaporate rapidly enough to prevent excessive concentration. So far as is known, the design of paving mixtures has not often been deliberately adjusted to provide the necessary permeability. It is hereby suggested that it is a possibility well worth consideration.

Economy is a factor which may at times influence the choice of gradings but its importance varies with the particular conditions. Durability is important for virtually all structures but is not usually affected by the gradation of aggregate. Surface texture is a property peculiarly important to pavement construction and the present widespread interest in traffic safety makes skidding resistance an essential property, and the texture is inevitably influenced by the grading of the aggregate. Important properties which are only slightly or indirectly affected by aggregate gradation are the *compressive strength* of portland cement concrete and the *stability* of bituminous mixtures.

A great deal of discussion has appeared in technical literature concerning the significance of the voids ratio. So far as the writer has been able to determine, there is little evidence to show that the voids ratio can be dependably utilized in the design of mixtures. Neither the amount of binder required nor the important properties can be confidently predicted from a knowledge of the void volume alone. As stated by someone, while a packing box full of baseballs and one filled with peas will have virtually the same void volume, the number of points of contact and the superficial area will vary inversely with the particle diameters.

Design of All Mixtures

In conclusion it may be pointed out that mineral aggregates are possessed of one inherent property which affects the design of all mixtures regardless of the type of binder used. This property is described as internal friction of the granular mass implying that all solid particles offer resistance to sliding depending on their surface texture and pressure with which they are held in contact.

The equilibrium characteristics of the mass depend on the conditions which pertain at the points of contact between the discrete particles. A void has little if any character and particles do not transmit their influence across void spaces—only at points of contact. The stability of bituminous mixtures is largely dependent on maintaining a high value of internal friction, while on the other hand, the strength of

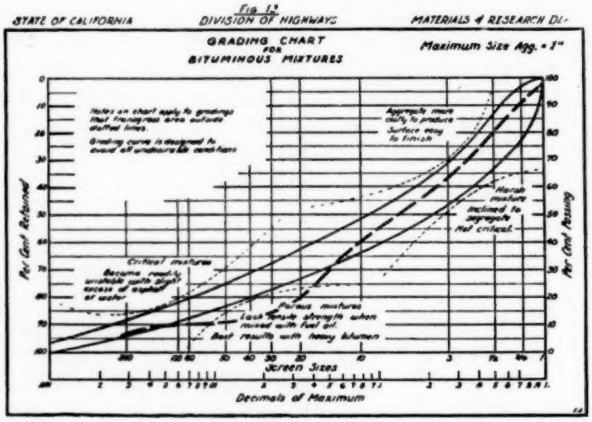


Fig. 13

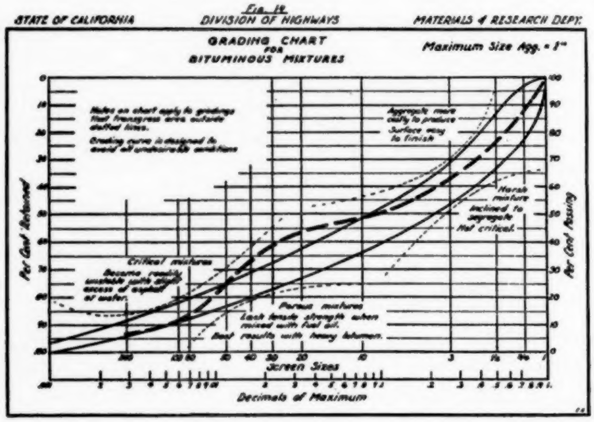
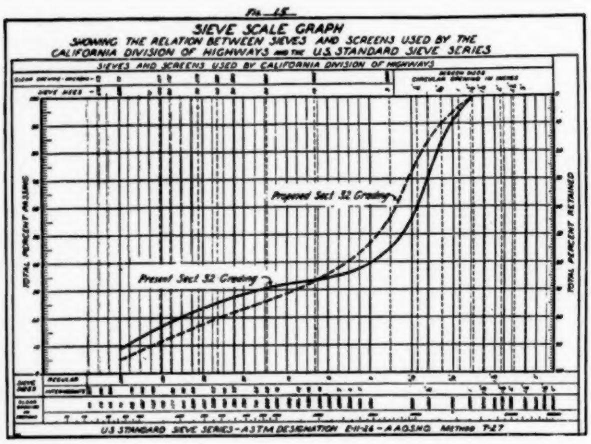


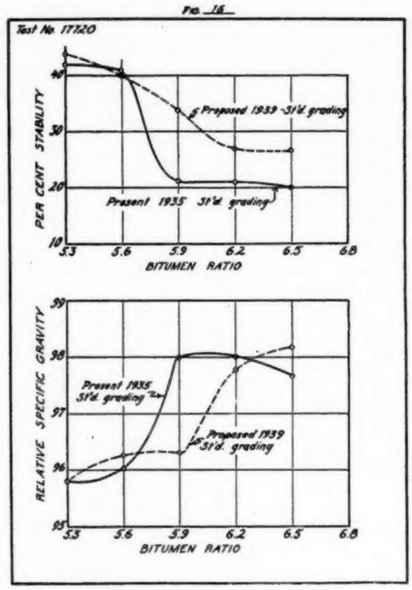
Fig. 14

Fig. 15



portland cement concrete depends on the water cement ratio. This ratio can be maintained at its lowest value when the internal friction of the aggregate is inherently low, therefore the design of portland cement concrete tends to encourage the use of finer sands and smooth particles which in combination with water, promote mobility. In bituminous mixtures, the tendency should be towards the use of rough stone and a reduction of fine mobile material to the lowest amount possible in order to maintain high internal friction. However, as the stability of

Fig. 16



bituminous mixtures is also influenced by the cohesion any reduction in the amount of fines tends to reduce the cohesion values as well as to increase the permeability, thus we are around the circle and back to the need for compromise.

Best Grading

The best grading for any particular mixture can only be that which utilizes the available aggregates to give as many of the desired properties as may be possible. For this reason standardization of aggregate gradings can easily be carried too far and as utilization of aggregates is primarily a local problem due care should be exercised in the adoption of national standards for materials which are strictly speaking, not manufactured and which vary throughout the country. Commercial aggregates are not often shipped long distances and there seems to be no good reason for requiring that crushed stone, sand, or gravel, in one region should meet gradations found satisfactory for materials at some distant point.

As an example of the manner in which gradings can be slightly modified to secure less critical mixtures, figure No. 15 shows for comparison the asphaltic concrete grading used in California for a

number of years past and the dotted line shows the modification which will be used in the future. The two gradings have virtually the same amount of sand finer than 10-mesh; however, the gradation of both fine and coarse material has been altered. This change in grading tends to reduce the density of the combination and will provide a mixture which is less critical.

Stabilometer Values

Figure No. 16 shows comparative stabilometer values of the old and new type of grading. You will note that with a bitumen content of 5.6 stabilometer values are virtually identical. However, with a slight increase in asphalt, the older more dense mixture tends to lose stability rapidly whereas the modified gradation will show satisfactory stability up to about 6 per cent of asphalt and in no case falls as low as the older type.

The lower chart shows variations in density with the two types. With 5.9 per cent of asphalt, the new gradation has nearly 2 per cent greater void volume and in this connection a large number of studies have indicated that when the relative specific gravity is higher than 97 per cent, virtually all asphaltic mixtures tend to lose stability. Sufficient void space must be provided for the necessary amount of asphalt and the new type of grading has been found to be more accommodating and less critical than the older type.

In conclusion, it can be repeated that the best gradation is that which best suits the particular purpose and material available and, to borrow a phrase from Mr. T. C. Powers, *"A wide variety of gradings can be used but we can not tolerate much variation."*

Discussion of Mr. Hveem's Article

By A. T. GOLDBECK
Engineering Director
National Crushed Stone Association

Aggregate Gradation

THE question of the most favorable gradation of aggregates is one which long has interested engineers having to do with pavement mixtures of various kinds, including bituminous as well as Portland cement concrete. Mr. Hveem's long experience with this general subject is evidenced in his informative discussion in the preceding article.

Aggregates are graded in different ways because it has been found in practice that certain maximum sizes and certain ranges of sizes seem, as a rule, to give the best results. However, there still is not unanimity of opinion as to the best gradation to use for given purposes and for this reason we find adjoining States using different size limitations for aggregates in identical types of construction. Evidently different sizes frequently give essentially the same results and this fact has been pointed out by Mr. Hveem as the result of careful observation in the field coupled with mechanical analyses of the aggregates used in the observed road surfaces.

For years attempts have been made to bring about a universal set of standard sizes which not only would be practicable from the production standpoint, but which also would be desirable because of the satisfactory construction obtained when these sizes were used. The advantages of universal standard sizes must be evident; much confusion and expense would be eliminated in many plants producing aggregates for adjoining States, and furthermore, much more accurate sizing would frequently result. The net result of such a universal standard would be greater satisfaction to consumer and producer.

It will not be amiss to repeat here the coarse aggregate size standard which has been recommended by the Division of Simplified Practice of the U. S. Department of Commerce. The sizes and typical uses in this Recommended Practice, R163-39, are given in Tables 1 and 2.

The above sizes and uses are not final and conclusive; they may require revision as time goes on and as more experience with them is developed, but they probably represent the best compromise set of sizes which has been developed up to date and they have been widely accepted either in full or with some revision to suit local needs. Their universal acceptance with such needed modifications as may later be demonstrated should be beneficial.

Sieves as a Measure of Size

We assume that irrespective of the shape of aggregates, they have the same size when they have the same mechanical analysis as determined by sieving

TABLE 1.—*Sizes of coarse aggregates*

[Crushed stone, gravel, and slag]

Size number	Nominal size square openings[a]	Amounts finer than each laboratory sieve (square openings), percentage by weight													
		3½ in.	3 in.	2½ in.	2 in.	1½ in.	1 in.	¾ in.	½ in.	⅜ in.	No. 4	No. 8	No. 16	No. 50	No. 100
1	3½ to 1½	90 to 100[b]		25 to 60		0 to 15		0 to 5							
2	2½ to 1½		100	90 to 100	35 to 70	0 to 15		0 to 5							
24	2½ to ¾		100	90 to 100		25 to 60		0 to 10	0 to 5						
3	2 to 1			100	90 to 100	35 to 70	0 to 15		0 to 5						
357	2 to No. 4			100	95 to 100		35 to 70		10 to 30		0 to 5				
4	1½ to ¾				100	90 to 100	20 to 55	0 to 15		0 to 5					
467	1½ to No. 4				100	95 to 100		35 to 70		10 to 30	0 to 5				
5	1 to ⅜					100	90 to 100	40 to 75	15 to 35	0 to 15	0 to 5				
57	1 to No. 4					100	90 to 100		25 to 60		0 to 10	0 to 5			
6	¾ to ⅜						100	90 to 100	20 to 55	0 to 15	0 to 5				
67	¾ to No. 4						100	90 to 100		20 to 55	0 to 10	0 to 5			
68	¾ to No. 8						100	90 to 100		30 to 65	5 to 25	0 to 5			
7	½ to No. 4							100	90 to 100	40 to 70	0 to 15	0 to 5			
79	½ to No. 8							100	90 to 100	40 to 75	5 to 25	0 to 5			
8	⅜ to No. 8								100	85 to 100	10 to 30	0 to 10			
9	No. 4 to No. 16									100	85 to 100	10 to 40	0 to 10		
10	No. 4 to 0[c]									100	85 to 100				10 to 30
G1[d]	1½ to No. 50					100	80 to 100		50 to 85		20 to 40	15 to 35	5 to 25	0 to 10	0 to 2
G2[d]	1½ to No. 8					100	65 to 100		35 to 75		10 to 35	0 to 10	0 to 5		
G3[d]	1½ to No. 4					100	60 to 95		25 to 50		0 to 15	0 to 5			

[a] In inches, except where otherwise indicated; numbered sieves are those of the United States Standard Sieve Series.
[b] 100 percent finer than 4 inches.
[c] Screenings.
[d] The requirements for grading depend upon percentage of crushed particles in gravel. Size G1 is for gravel containing 20 percent or less of crushed particles; G2 is for gravel containing more than 20 percent and not more than 40 percent of crushed particles; G3 is for gravel containing crushed particles in excess of 40 percent.

tests. But it is quite evident that the actual dimensions of the pieces passing square opening sieves must depend in part on their shape. Thus, if the piece is practically spherical, its size can closely approach that of the nominal sieve opening. This is not necessarily true of the piece which is flat. Such a piece could have a width which approaches the diagonal dimension of the sieve and thus the width of such a piece could be almost 1.4 times the diameter

(*Continued on page 26*)

TABLE 2.—*Typical uses for sizes given in table 1*

Use	Size number and nominal size[a]																			
	1	2	24	3	357	4	467	5	57	6	67	68	7	79	8	9	10	G1	G2	G3
	3½ to 1½	2½ to 1½	2½ to ¾	2 to 1	2 to No. 4	1½ to ¾	1½ to No. 4	1 to ⅜	1 to No. 4	¾ to ⅜	¾ to No. 4	¾ to No. 8	½ to No. 4	½ to No. 8	⅜ to No. 8	No. 4 to No. 16	No. 4 to 0	1½ to No. 50	1½ to No. 8	1½ to No. 4
Water-bound macadam:																				
Coarse aggregate	×	×		×																
Filler																	×			
Bituminous macadam, penetration method:																				
Coarse aggregate	×	×		×																
Choke								×		×	×			×						
Seal															×	×				
Bituminous plant mixes[b]																				
Base or surface courses:																				
Base, open mix				×		×														
Base, closed mix					×		×		×											
Binder course									×		×									
Surface course, coarse grading								×	×		×									
Surface course, fine grading															×	×				
Seal															×	×				
Bituminous road mix:																				
Mixing course								×			×									
Choke															×	×				
Seal															×	×				
Drag leveling course:																				
Leveling course											×	×		×						
Seal															×	×				
Bituminous surface treatment										×		×		×	×	×				
Seal for airport construction																×				
Portland cement concrete	×	×		×	×	×	×		×		×		×							
Railroad ballast:																				
Stone or slag			×	×		×		×												
Gravel																		×	×	×
Roofing															×					

[a] In inches, except where otherwise indicated; numbered sieves are those of the United States Standard Sieve Series.
[b] For plant mixes the aggregate should consist of appropriate sizes selected from table 1 combined with suitably graded fine aggregate.

Development of a Sound Depreciation Policy[1]

By A. B. HOSSACK

The American Appraisal Co.
Milwaukee, Wisconsin

• Though always of basic importance, a sound depreciation policy becomes even more essential during a period of increasing taxes. Mr. Hossack is authoritatively qualified to discuss this important subject and it is believed his observations should prove decidedly helpful.

YOU will recall the old saying that "Nothing is sure but death and taxes," also the one that "The exception proves the rule." Accordingly, I would suggest that we might concede in starting this discussion to the premise that "Nothing is sure but death and taxes, except depreciation."

In consulting Webster's dictionary to make sure just what "Development of a Sound Depreciation Policy" meant, here is what I found:

Development—Evolving the possibilities of
Sound—Safe
Depreciation—Lessening in price or estimated value
Policy—Procedure, based primarily on temporal or material interest, rather than higher principles.

It would seem then that I should discuss the possibilities of evolving a safe procedure to serve a temporary advantage in estimating the lessening in price or value. This is quite an assignment for an engineer or appraiser.

My experience with fixed asset accounting in industry, over a considerable period of time, has lead me to believe that the above definition, in no small part, has motivated many industrial, commercial, and utility companies in their depreciation practices. Depreciation accounting has too frequently been the result of trying to obtain a temporary advantage rather than trying to face the facts, or estimate honestly the deterioration and obsolescence occurring due to age, use, and improvements in the arts of production.

The facts should have the greater weight in the determining of depreciation allowances. I doubt that it is safe to try to guess as to temporary advantages that may be gained by expediency. This is particularly true in facing the present and prospective high tax rates confronting business today. It may prove expensive if your depreciation deductions are challenged in the future, allowable allowances decreased and deficiencies and interest asserted.

[1] Presented before a meeting of The National Association of Cost Accountants, Allentown, Pa., April 24, 1941.

It is my opinion that the only safe policy at present is to establish and maintain as logical and factual a basis for your depreciation accounting as is possible. With this preface and stress as to what is sound or safe in present depreciation accounting, I shall try to convey to you some principles which I think are basic to the problem and leave to others the guessing as to temporary expediencies that might not be of ultimate advantage.

Foundation for Depreciation Accounting

If any business, or individual wants to control depreciation on tangible assets used in production, a detailed record or inventory of the property is necessary so that it is possible from time to time to verify the continuing existence of the assets in production, their physical and economic condition, and probable future useful life.

More companies are now adopting better methods for practical control of their investment in tangible assets. The idea that investment in plant facilities was fixed and not necessary of control is disappearing, just as the former ideas that cost of production was unnecessary have largely disappeared.

The foundation of any depreciation control is an inventory of the assets. It is usually most economical to plan some form of perpetual inventory record, as the assets, in large part, last several years. Such a record should usually be supplemental to the general ledgers through reconciling or tying-in with the general books, by accounts or departments. This supplemental record may be kept in one of several forms, such as loose-leaf, card record, tabulating record, or any other form so long as a few basic principles are served.

The record should be flexible so that additions or retirements may be recorded and inserted in proper sequence. It should contain sufficient description to identify the asset, as well as to provide for location by building, floor, or department. It should be of

suitable form so that the record may be physically used to check the property from time to time, as required, to see that the assets recorded on the books are still in existence and useful in plant production. It should record the cost or other depreciation base, together with the life estimate or average rate, or other basis to be used for depreciation calculations.

I have found that the loose-leaf record has many advantages as a foundation for depreciation accounting—

> It permits of adequate size for recording descriptions, cost data, etc.
>
> It permits the making at one operation of two or more copies which are often desirable.
>
> It has all the flexibility of a card record without the bulk in thickness.

The tabulating record has an advantage in computation and summarization but is limited in recording an adequate description for identification.

A very helpful tie-in with the basic record is to attach brass tags to machines or other movable equipment when installed, and the use of such numbers for reference on the property record. Another help in later identification is the recording of the manufacturer's serial numbers when attached to equipment. Building numbers painted over doors entering each building helps in reporting plant changes to the Accounting Department.

Methods of Computing Depreciation

There are many methods of computing depreciation. I shall not try to expound them all, even if I could. I am not going into the various bases that might be used such as Reproduction Cost versus Original Cost but will limit this discussion to the usual straight-line methods of computing depreciation on the basis of life or rate estimates with some mention as to the advantage or disadvantages of average rates, item rates, or some basis for recognizing the variations in depreciation that occur as the result of the amount of production.

Average Rates

While my own experience has indicated that item or limited group rates furnish a better control of depreciation, I have no quarrel with the use of average rates. I will venture the observation that most average rates that I have seen used in the past have been determined more as a matter of expediency than an attempt to obtain proper average rates.

The use of averages reminds me of the story of a man taking a sleeper overnight for a business trip. This fellow was young and had little traveling experience but as the porter was very anxious to please he realized that a tip was expected. He was traveling on the firm's expense account and was anxious to do what was usual, so when the porter was brushing him off he inquired as to the extent of his gratuities, and what the average tip was that he received. The porter explained that the tip varied but that the average was a dollar. The young man thought this was a bit stiff but did not want to seem too small and gave Sam a dollar bill. The porter was profuse in his thanks and wound up by saying, "Boss, you's the first one to come up to the average yet."

I often wonder if some of the average rates adopted over the past years were not the same kind of averages used by Sam. The amount of the fully depreciated assets in comparison with the total assets, and the ratio of reserves to costs, would lead one to think so.

Average rates of depreciation or composite rates as they are sometimes called, usually contemplate that within the group or account, there are items of varying life expectancy. The rate is supposed to be that warranted by the average life for the group of property controlled in the account. If an average rate is properly determined and if the property lasts its life span contemplated in making up the average, the use of the average rate will recover the cost of the assets over the total life.

To use a few more "if's"—If you don't determine the average life with some consideration to the probable life of the various items in the group and their relative cost—If the replacements have different life expectancies due to change in construction or production—If the assets last longer or shorter than the estimate—If the plant increases in size and additions have a different average than the former property—If price changes distort the average investment—Then your resulting depreciation may be too much or too little and it is most difficult to convince the representatives of the Bureau of Internal Revenue that your rate is too low and should be increased, or to convince yourself that the rate is too high and should be decreased.

If an average rate of depreciation is to be adopted with an adequate property control, some care should be used in determining such average rate based upon an estimate of normal life expectancy and relative investment. It is not necessary to carry out such averaging to mathematical precision. In most accounts, there are large units or groups that can be

readily tested and which will control the proper average for the account. For example, in a building account, it is usually easy to obtain the cost of major structures and such items as sprinkler system, wiring, building elevators, and to use some judgment as to reasonable life expectancy for the different structures or their equipment. You then have some basis to assure yourself, your management, or the Bureau of Internal Revenue that your deduction claimed is reasonable.

Such an analysis would also indicate whether life over a period of years was consistent with your estimates and whether changes were warranted. This analysis might well be desirable proof in determining whether retirements in the average group were normal and should be charged to the reserve, or whether there was special obsolescence or properly allowable losses that should be recognized in profit and loss for accounting purposes.

Care should be used when average rates are utilized to make sure that additions are such that the averages used for former assets are also proper for the additions. Additions made to an old building where a rate of 2 per cent may have been proper originally, but where the remaining life is now only ten years, should not go into a 2 per cent account, unless you expect to have losses on retirements to absorb later on.

There has seemed to be much confusion in the application of average rates. There have also been some confusing decisions in Federal tax cases involving average rates. It is my belief that these results were due to lack of factual data or real effort to establish or record the depreciation for the assets properly allowable to recover the cost over the probable useful life of the group of facilities in the account.

If you desire to use an average rate for an account or group of assets and want to have a basis that you feel is correct, I urge you to make some analysis of the cost and probable life of the property in the group. Then if you want to try to adjust for expediency, for possible future obsolescence, or other contingent factors, you at least know something of the property facts and the hazards involved.

Average rates are adaptable for some properties and for some accounts. For example, in a utility company, average rates are generally desirable for transmission lines, meters and similar groups of assets even though item rates in general may be better for power stations, repair shops, etc. For industrial companies, average rates are many times more practical for such accounts as special or standard tools, office furniture and fixtures, exclusive of office machines, dies, patterns and similar accounts.

Item Control of Depreciation

Item rates of depreciation are in most cases better adapted for the usual production assets found in most industrial properties. Possibly, item control of depreciation is a better term than item rates. Where depreciation is computed on individual major units, it is usually based upon consideration of the probable useful life of the particular item or unit of property. The calculation may be expressed as so many years, or it may be a rate based upon the years estimated that the property will remain in use.

It seems more logical to think in terms of years of life and I have found it more helpful to convert such estimates of life into dollars of depreciation per year. The average individual, if he is dealing with a rate, is apt to think of the conventional rates such as 2%, 2½%, 3%, 3 1/3%, 4%, 5%, etc. The natural result is then to try to classify all assets into such rate groups. The result is apt to be certain average rate groups when the record is complete.

It is no more work with a properly planned system of property control records to deal with years of life, and compute the dollar depreciation per year. If such a procedure is adopted, then it is just as simple to assign a life of nine years or eleven, if such life is deemed proper, as to say ten years which means an even rate percentage. If a new mezzanine floor is added to a building having twenty-six years remaining life and the mezzanine floor should be depreciated over the remaining life of the building, then one twenty-sixth is the annual depreciation to be charged off each future year. If you happen to use one-half year the first year, then 25½ or 26½ years for the addition is equally easy to compute. It is certainly more accurate than to add the cost to a group rate for all buildings that may be 2 or 3 per cent per year.

If salvage is a factor, it is equally as easy to divide 90 per cent of the cost by the years of useful life, thus leaving the 10 per cent for salvage at the expiration of the estimated useful life. The use of item control for depreciation deductions usually produces better results in the control of plant assets, if for no other reason than that the property record clerk tries to find out what the property is, where located, how used, whether the useful life is dependent on other assets, and similar factors affecting the future useful life. In other words, it tends to make one think about the proper recovery of cost. Most of the depreciation thinking has been on theory and too

little on facts affecting future utility in a particular property.

When I speak of item control of depreciation, I am not referring merely to an item control of costs. You must, of course, have your costs segregated to apply item control of depreciation. But setting up individual cost records and then applying ten per cent depreciation on each item does not constitute an item control of your depreciation. It is still a group rate though individually applied. Yet I have had accountants tell me that they had an item depreciation control under such a system and really take offense when challenged.

Some of you who are using other methods are probably saying, "Sure, that is fine, but it is too expensive and not practical." My answer is, that such a system is practical for big or little business, if thought out and adapted to meet the individual problems. It is the *safe* way to set up a depreciation control that you can support. Any control of accounts, you cost men know, costs something. You cannot have even the most sketchy cost system without some expense. You cannot control inventory without records or a periodical physical check. That costs money too. The same applies to plant asset control. It will involve a modest cost.

The point for you and your management to decide is, can you afford to guess at your depreciation deductions and your control of plant investment? Your plant investment is usually a substantial part of your total invested funds. A modest expenditure each year will give you a reasonable control of this investment and reasonably assure the recovery of cost over the life of the assets used in producing income.

Depreciation is not an exact science. There is seldom a basis for definite predetermination as to the total future life. Accordingly, depreciation must be estimated in the light of those conditions known to exist at the time. An adequate control must permit of periodical check or review and a system that can readily give effect to warranted changes in the annual provisions. An item control of the dollar deduction permits of such control, as the balance remaining undepreciated may be readily computed and the future provision increased or decreased if the probable life indicated by a reinspection be shorter or longer in the light of subsequent available facts. It is much more difficult to test or correct averages, or group rates, or lives.

Adjustment of Depreciation Due to Variations in Production

Some of you may recall the gymnastics utilized during the former high tax years to accelerate depreciation. The arguments then advanced are again being discussed. The arguments are not new—overtime, double shifts, twenty-four-hour operations, inexperienced help, lack of maintenance, et cetera. I am not optimistic that the Internal Revenue Bureau representatives will be as gullible as before in accepting these general claims. They have been studying depreciation and acceleration. That additional operations result in additional wear and tear and the shortening of the life of most production facilities, I do not question, but I do not believe you can anticipate allowances of double or triple normal as was obtained by many concerns during the prior period of high taxation. As a matter of fact, many concerns have excess reserves by use of normal rates and to get further acceleration for recovering the balance will be difficult. One factor to consider in claiming any acceleration is that the amount of use does not normally affect the obsolescence occurring and that many manufacturing establishments' facilities are retired due to the fact that they are obsolete rather than that they are worn out.

For many companies where the useful life of equipment is shortened due to the extent of the use or hours of operation it is constructive to adopt a basis for increasing or decreasing depreciation in comparison with a developed normal, depending upon whether operations are over or less than a normal average. I believe such a plan for depreciation is constructive for many industries. I believe that such a plan is desirable not only for tax purposes, but also for general financial accounting. When production is accelerated, most industries' equipment wears out and is discontinued sooner. When production is light, equipment is used longer and the life expectancy extended. When production is high, usually profits are greater and the increased depreciation charge can be absorbed and profits to some extent equalized. When production is low, profits are limited or do not exist, and anything that can reduce the fixed charges is usually quite acceptable by the operating personnel.

With prospective high taxes, anything that can properly be done to assure the recovery through depreciation deductions of the full cost against taxable income is an advantage for tax purposes as well as better for financial accounting. Any such basis should in my judgment give due consideration to the factors of obsolescence as well as wear and tear, in

other words, the depreciation adjustment should not be increased or decreased in direct proportion to the increase or decrease in the relation of production to normal standards.

For instance, assuming that equal weight were to be given to obsolescence and wear and tear in any such production adjustment for depreciation, then a 50 per cent decrease in production would result in a 25 per cent modification in depreciation provisions and similarly, a 50 per cent increase in production over normal would result in only a 25 per cent increase in depreciation. Such a production basis for depreciation should also apply only to such accounts controlling property of a type that the life of the property is affected by the extent of the production. For instance, it is rather rare that any shortening of life or acceleration of depreciation is warranted on the building account.

Factors Affecting Useful Life

While we may disagree on methods or as to expediency, which may be the topic I should have talked more about, yet I think we can agree, looking back on the past, that if we depreciate so that the cost or other base is recovered over the useful life of the respective assets, we have at least a basic record that we need not apologize for. Many firms are being allowed less than a normal depreciation charge now due to excessive charges in prior years.

Any policy for depreciation accounting should be determined with an understanding of accounting policies for handling repairs, replacements, and maintenance. If you are to capitalize, or charge to the reserve, new roofs, painting, new floors, etc., then your rate applicable to the building must be higher than if such charges are to be expensed.

Again, I think the *safe* policy is to have a definite plan for treating these charges and determine your depreciation consistent therewith. If you do, then disputes as to reasonableness of expense charges should be lessened.

Reasons for Depreciation Control

While the reasons for a proper control of depreciation seem rather obvious, still it might be helpful to summarize some of the reasons why a correct control of depreciation is desirable.

One of the first that might most logically be mentioned is, that it is just naturally good business to have the investments in depreciable plant facilities under adequate and proper control. As previously mentioned, for most companies the fixed assets represent a substantial part of the total investment by the owners or stockholders in the company. Whether or not the capital was contributed, or whether the plant facilities have been acquired by the investment of earnings retained in the business the amounts represent an investment of capital in the business.

Good management dictates that this investment should be under proper control. In the past, I venture to say that the fixed assets have been under the least adequate control of any capital employed in the business. You employ accountants, both inside and usually outside of your own organization to check such items as cash, accounts receivable, to check or verify capital invested in inventory, work in process, and finished stock, yet too many concerns over a period of years make no effort to verify whether the capital invested in plant assets is still in existence, whether the depreciation provided is adequate, or whether the property is in such condition that it is, or can be, used in production.

A second reason for a better control of depreciation is that many companies today are limiting the extent to which they are willing to invest funds in new facilities to the amount of the annual depreciation provided.

It is more difficult today to raise additional capital due to the uncertainties of profitable operation, tax burdens, and similar factors. It is not to be wondered at that management hesitates to provide funds for expansion and even for desirable replacements. An adequate control of depreciation providing funds currently, by a charge against operations for the depreciation actually accruing, should permit of a more adequate replacement policy, in order that the owners may be assured of a continuity of operations and potential profits.

A third reason for better control of the depreciation provisions, is the increasing requirement for revealing to stockholders adequate information on operating results and the requirements of publicly owned corporations to file data with various regulatory bodies. In a number of cases, the SEC at Washington has questioned depreciation provisions.

The fourth reason should need little amplification before a body of Cost Accountants, namely, that depreciation in many companies is an important element of fixed charges. If you have a cost accounting system and prices are at all dependent on the costs of production, then you are, or should be, interested in having these charges as near as possible in accordance with the facts.

The last reason I will mention for adequate depreciation control, is taxation requirements. During my some thirty years of business experience, I have never felt that it was ever more important than now to correctly determine depreciation for taxation requirements.

Taxation is taking an increasing part of every profit dollar and we must look forward to tax rates at probably higher levels than exist at the present time for a considerable period in the future. It is going to prove expensive if depreciation claims do not have as adequate a support as possible, in order that they may be explained and maintained as to their reasonableness when questioned in the future. To have a deficiency tax asserted, with interest two or three years hence, may be serious, and I think that taxation requirements alone justify an adequate property control. In fact, for any concern where the depreciation deduction is at all substantial in comparison with net earnings, a concern cannot afford to be without a proper depreciation control of their plant assets. The depreciation may be a small element of total cost, but may bear an important relationship to the amount of net income available after depreciation provisions, so that any disallowance of depreciation may have an important bearing on taxable income.

I suggest you review and consider your own situation from this point of view when considering the desirability of adequate depreciation control.

Amortization

Amortization provisions of the present income tax laws will have some effect on depreciation accounting. That additional facilities for meeting the Defense Program should be brought within the amortization provisions is obvious, as this amortization provision reasonably assures the recovery of total cost against taxable income. The future utility of these excess facilities may well be questionable, depending upon later readjustments in manufacturing requirements.

I am recommending to our clients who are acquiring facilities that are such as to qualify for a Certificate of Necessity, that these be set up in a separate account with subsidiary records identifying the property and its cost, as well as date of completion, and the the sixty months' amortization provision. It usually is desirable to have a sub account for each separate certificate covering emergency facilities as issued. Ultimately if any taxpayer elects to revert to regular depreciation deductions, the costs and reserves set up for amortization or the net unamortized balance may be transferred into the proper asset accounts.

I do suggest that a detailed subsidiary record showing adequate description, location, and other identification of the property is very necessary for later check by the Bureau of Internal Revenue, or for other Federal Bureaus that may be interested. Such a record can be prepared at the time rather easily and may obviate considerable future controversy and unnecessary detailed research.

Invested Capital

This subject is one of rather general interest at the present time. There are one or two factors wherein depreciation reserves and fixed asset accounting may be important to this question.

The regulations seem to indicate that plant assets should carry forward for invested capital on the same basis used for depreciation purposes, or the basis for determining gain or loss on sale or disposal of assets. This base may be simply summarized as cost less depreciation allowed, but not less than that allowable. This may raise to more importance the question as to whether excessive depreciation claimed in loss years was, in fact, allowed when it did not offset taxable income. This point is still disputed by the Bureau, even though they acquiesced in the Pittsburgh Brewery Company case. At least a condition of excessive reserves whether accrued in profit or loss years may well constitute a proper abnormality for special consideration by the Commissioner.

Other questions of plant asset accounting that may constitute abnormalities are such items as:

(1) Acquisition of properties at Receiver's sale.

(2) Amortization allowed on facilities that contributed to the prior war that are now used in production.

(3) Capital assets expensed in prior years.

A proper record of depreciable assets may be warranted to establish the extent of the abnormality for your specific property.

(The opinions expressed in this Bulletin are those of A. B. Hossack and do not necessarily represent the opinions of the Management.)

Truck Pooling for Defense[1]

By FREDERICK C. HORNER

Member U. S. Civil Defense Commission to England and Consultant to Ralph Budd, Commissioner, Advisory Commission to the Council of National Defense

• **The threatened shortage in transportation facilities makes especially significant the following observations by Mr. Horner, based upon an intensive study of transportation facilities in Great Britain.**

THE truck industry of the United States should begin immediately the making of plans that will enable highway transportation to fulfill every demand which civil defense requirements are likely to make on it in the event of dire emergency. In these plans the establishment of pools of reserve vehicles should be given prime consideration.

That is my advice to the truck industry based upon what I learned during the 27 days I spent recently in England as a member of the Civil Defense Mission of the United States War Department. My job was to study transportation, communications and public utilities under war-time conditions.

My advice is just a repetition of the advice that was volunteered in every authoritative English quarter: "Don't wait until the pressure is on; don't wait until the blitz is upon you; plan now." That advice is valuable because it comes from a country that failed to make plans itself; that restricted truck transportation and favored the railroads; that has learned to appreciate the flexibility of motor trucks, and that, because of these things, is reduced to scrambling for a solution now that a transportation emergency exists.

It is no secret that transportation is a major problem in England. The English trade press reaching this side of the water makes no secret of it. Over there, as over here, the railroads have been telling the public that they had plenty of equipment to take care of any emergency. Today the English railroads are still saying, "We can take it." They can, of course, but with no promise of delivery.

The railroads are congested, docks are congested and tardily, the official attitude toward trucks has changed. Tardily because the relief that trucks could provide in the emergency is materially affected by the restrictions imposed in peace-time and in the early months of the war. The importance of trucks in the war effort was not recognized. Truck manufacture, parts manufacture and fuel distribution were so restricted that, at the time I left England late in February, it was not possible for an operator to purchase new trucks and officialdom was just becoming aware that the usefulness of old trucks was being jeopardized by the lack of repair parts. The United States, of course, will be depended upon to furnish new trucks now that we have decided on a lease-lend all-out effort.

The attitude of English officialdom toward road transport has changed but the plans for making maximum use of trucks are being made under pressure of time and circumstances and resulting in considerable friction. The problem will undoubtedly be solved but at a tremendous economic and, I fear to some extent, National Defense loss and an untold amount of industrial delay and public inconvenience.

But one of the plans that has general approval is the so-called "Road Transport Pool." This pooling of vehicles originated with the users of trucks themselves. Limited in the way of vehicles, of rationed fuel and with deliveries by railroads unpredictable, various business groups organized traffic pools and invited local and long distance for-hire haulers to join the pools. Thus specialized traffic pools grew up in the large shipping centers. In Liverpool, for instance, there are local cartage pools for handling bacon and hams from ship to cold storage; butter, cheese and eggs from ship to cold storage and warehouse; canned meats from ship to warehouse; heavy meat from ship and cold storage to wholesale markets, and meat distribution from markets and abattoirs to retailers. There is also a general pool that in addition to distributing foodstuffs and raw materials to all parts of the country assists port authorities in keeping the quays clear of goods.

When the inability of government-controlled railroads to handle necessary traffic became all too apparent, the Ministry of Transport, which now exercises control authority over all forms of transportation, adopted a policy of utilizing trucks which was termed an official reversal of policy. The Ministry perceived the merit of the vehicle pools and proceeded to organize and operate its own haulage pool. The Ministry hires vehicles from haulers primarily to carry traffic on Government account. Vehicle ownership is not affected and participating operators continue to be responsible for the actual operation

[1] Reprinted from May, 1941 issue of *Commercial Car Journal.*

and maintenance of the vehicles concerned. Participation is voluntary. At the outset participation was restricted to for-hire haulers. It was indicated that later on the scheme might be broadened to include private carriers. Payment for vehicles is made by the Ministry on the basis of profits earned in a standard year. This means that any hauler participating in the pool will be guaranteed the same net revenue per ton of pay-load capacity as he earned in a standard year. *No extra* profit due to war conditions!

The vehicles attracted by the pools are largely those of occasional haulers with relatively few trucks, and the spare vehicles of the larger haulers who do business with their regular customers. The Ministry of Transport has power to decide how many units the operator can spare!

Another form of vehicle pool is the emergency transport pool. This supplements all other road transport arrangements. Its basis is mutual aid. These pools are intended to provide any area suffering intensive air attack with road transport facilities for clearing up the debris, removing furniture, supplying water, medical supplies and emergency rations. Municipal authorities and private operators collaborate in these arrangements. Pools are set up on district basis.

Planning by the truck industry of the United States should include study of the ports and large terminal and industrial areas where congestion of transportation facilities and disruption of distribution services are most likely to occur when the all-out effort begins hitting on all cylinders, and also in the event that this country is attacked. When the critical areas have been determined steps should be taken to plan the formation of pools of trucks that would be called into being at the first indication of a developing transportation emergency. If we are attacked these pools would be called into being and stand in readiness to furnish emergency aid to bombed areas, and supplementary aid to military forces if they found such assistance imperative.

Planning should include managerial control of pools. Control of a pool should not be in the hands of committees or in the hands of bureaucrats. It should be vested in a man with brains and ability, a man who knows truck transportation, and that man should be given a free hand to pick his staff of advisors and be given dictatorial powers in the operation of the pool. Committee haggling is just another form of congestion.

But before the industry can make plans for the establishment of pools it must know what sorts of vehicles are available for pooling purposes. It is essential, therefore, that a census of trucks be taken which would reveal the types of body equipment in use and the load capacity of the equipment. It would reveal where the equipment is garaged, and should procure from all classes of truck owners an idea of the number of trucks they have in reserve to take care of traffic peaks, and what vehicles of that reserve they would make available for pooling purposes. This available reserve should be cataloged and for the duration of the emergency the catalog should be kept up to date.

A vehicle census of this kind has been under consideration by the National Defense Council. Proposed questionnaires have been developed by the Public Roads Administration for use by State Highway Departments. The truck industry should urge that the census be undertaken as quickly as possible. The truck industry cannot work out its plans on a practicable basis until the census produces the necessary facts.

I realize only too well that the pooling idea is a radical one and that the suggestions I have made do not begin to cover the many organization problems that will immediately occur to truck operators. But we must discuss those problems now and solve them in such a manner that we will be able to handle the emergencies that will inevitably arise. Unless we make definite plans now to take care of them efficiently, we will certainly experience commandeering of vehicles by local, state and federal authorities which will disrupt normal road transport services, prove far more costly to the industry and the nation than the remedy I suggest, and simply intensify the emergencies.

Meanwhile legislators should be made to realize that the national defense effort demands the utmost of motor trucks, and that while trucks are willing they are hampered by restrictive measures. In England, mention of barriers such as exist in the State of Kentucky caused amazement and brought the question, "Why is the condition tolerated?" The transportation problem which the English have in their laps today is largely the result of peacetime restriction of road transport. They realize it now. The experience of England should serve as an example to the United States that nothing should be permitted to interfere with the development of highway transportation and that each form of transportation should be allowed to seek its economic level. Politically-inspired restrictions should not be permitted to interfere with national defense, which is of paramount importance.

Crushed Stone Safety Competition of 1940

(Continued from page 7)

The 4 underground mines worked 375,987 man-hours. This group reported 9 injuries (1 permanent partial and 8 temporary) causing 5,388 days of disability. The accident-frequency rate was 23.737 and the accident-severity rate was 14.330. Corresponding rates for 1939 were 20.354 and 2.689.

TABLE 7

DAYS OF DISABILITY BY CAUSES OF INJURIES AT QUARRIES AND UNDERGROUND MINES IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION IN 1940.

Cause	Fatal	Permanent Total	Permanent Partial	Temporary	Total
Falls and slides of rock	—	—	—	356	356
Handling materials and rock	—	—	—	187	187
Hand tools	—	—	600	378	978
Explosives	—	—	750	—	750
Haulage	—	—	—	215	215
Falls of persons	6,000	—	300	1,228	7,528
Bumping against objects	—	—	—	38	38
Falling objects	—	—	—	305	305
Flying objects	—	—	—	7	7
Electricity	—	—	—	7	7
Drilling	—	—	—	41	41
Machinery	—	—	5,400	791	6,191
Stepping on nail	—	—	—	—	—
Burns	—	—	—	5	5
Other causes	—	—	—	—	—
Not stated	—	—	—	343	343
Total	6,000	0	7,050	3,901	16,951

The combined record for the open quarries and underground mines covered 4,734,396 man-hours of work, a slight increase over 1939. Accidents in 1940 occurred at the rate of 19.643 per million man-hours worked, compared with 13.660 in 1939. The accident-severity rate of 3.580 was the lowest since the contests were inaugurated with the exception of two years, 1933 and 1934. The average duration of disability per temporary injury went up from 37 days in 1939 to 45 days in 1940. Ninety-three injuries (1 fatal, 6 permanent partial, and 86 temporary) caused 16,951 days of disability.

The principal causes of accidents in 1940 were falls of persons, hand tools, and machinery. Of the 16,951 days of disability, 44 per cent were due to falls of persons, 37 per cent to machinery, 6 per cent to hand tools, and 13 per cent to remaining causes, as shown in the accompanying table 7.

Tables 1 and 2 show the relative standing of plants enrolled in the contest, arranged according to their accident-severity rates. When two or more plants have accident-free records, the contest rules provide that the number of man-hours worked shall govern the order. Tables 3 and 4 show yearly summary figures for all enrolled plants from 1926 to 1940, and for Association members for 1925, the year before the contests were organized. Table 5 shows a yearly summary covering both open quarries and underground mines that were enrolled in the contests. Tables 6 and 7 show the number of injuries by causes and the days of disability by causes of injuries in 1940. Table 8 shows the average days of disability for temporary injuries at mines and quarries enrolled in the contest.

TABLE 8

AVERAGE DAYS OF DISABILITY FOR TEMPORARY INJURIES AT PLANTS ENROLLED IN THE NATIONAL CRUSHED STONE ASSOCIATION SAFETY COMPETITION

Year	Underground mines: No. of temporary injuries	Underground mines: No. of days of disability	Underground mines: Av. days of disability	Open quarries: No. of temporary injuries	Open quarries: No. of days of disability	Open quarries: Av. days of disability	Total: No. of temporary injuries	Total: No. of days of disability	Total: Av. days of disability
1925	29	228	8	292	5,286	18	321	5,514	17
1926	34	533	16	207	4,239	20	241	4,772	20
1927	14	68	5	458	7,186	16	472	7,254	15
1928	68	888	13	322	5,493	17	390	6,381	16
1929	30	617	21	286	5,533	19	316	6,150	19
1930	15	468	31	227	3,671	16	242	4,139	17
1931	4	147	37	198	3,540	18	202	3,687	18
1932	6	165	28	75	2,481	33	81	2,646	33
1933	11	349	32	67	2,893	43	78	3,242	42
1934	13	287	22	106	1,873	18	119	2,160	18
1935	3	249	83	77	3,015	39	80	3,264	41
1936	7	117	17	182	4,590	25	189	4,707	25
1937	3	91	30	136	4,461	33	139	4,552	33
1938	2	133	67	76	3,184	42	78	3,317	43
1939	7	457	65	51	1,678	33	58	2,135	37
1940	8	888	111	78	3,013	39	86	3,901	45
Total	254	5,685	22	2,838	62,136	22	3,092	67,821	22

Discussion of Mr. Hveem's Article

(Continued from page 16)

of the spherical piece. This would be the extreme case, but the width of the more usual flat piece could well be 1.2 times the nominal opening in the sieve and its length could be even greater. This effect of shape on the actual size of pieces passing a given sieve opening is of importance in connection with the property of workability of concrete—especially concrete for use in reinforced structures. Are we interested in size as determined by nominal sieve opening or are we interested in the actual size of the pieces?

Water-Cement Ratio

Mr. Hveem makes one statement that bears looking into more fully, namely, "* * * the strength of Portland cement concrete depends on the water-ratio." So it does for any given coarse aggregate, but if that statement is interpreted literally, it means that we can forget entirely the fact that aggregates differ widely in their surface smoothness which influences mechanical bond with the mortar; that the surface area as between angular and more equi-dimensional aggregates varies and that this influences bond; that aggregates have different degrees of absorption which probably has influence on bond and also that the physical characteristics as determined by such tests as the Los Angeles abrasion machine influence the strength of concrete—particularly the beam strength. Other physical and chemical characteristics of aggregates have only recently been recognized as having importance in their influence on concrete durability—thermal effects, and the presence of constituents which can produce volume change upon combining chemically with others supplied by the cement are cited.

Workability of concrete made with angular aggregates, practically equal to that made with rounded aggregates is secured by increasing the sand content without necessarily maintaining the same water-cement ratio and without increasing the cement factor. If the same cement factor is maintained the water-ratio would generally increase to maintain a given slump as more sand is added. But this increase in water-cement ratio is generally not enough to influence either compressive strength or durability to an important degree. Furthermore, one concrete, having a higher water-cement ratio and higher sand factor than another concrete, may still very materially exceed it in strength, particularly in beam strength. This fact has been demonstrated by a number of investigators; quite recently by W. F. Kellermann of Public Roads Administration ((1) "Designing Concrete Mixtures for Pavements", A. S. T. M. Proceedings, Vol. 40, 1940) and years ago through our own investigations. ((2) N. C. S. A. Bulletin No. 7, "Investigations in the Proportioning of Concrete for Highways".)

It is strongly urged that the limitations of the water-cement ratio method alone as a means for designing or specifying concrete, on the assumption that equal water-cement ratio is all that is needed to insure concretes of like quality be recognized. Such an assumption ignores factors which are important in controlling the quality of concrete. A more suitable basis for concrete specifications is the use of a specified cement factor per cubic yard of concrete, with a limiting maximum water-cement ratio and a required consistency.

Regular Federal-aid Funds Used for Defense Highway Construction

USE of regular Federal-aid funds for construction of 4,262 miles of defense highway and for engineering work on an additional 1,548 miles has been approved in the past year, Thomas H. MacDonald, Commissioner of Public Roads recently reported to Federal Works Administrator John M. Carmody.

The regular Federal-aid funds apportioned to the States each year are available only for designated Federal-aid systems. Mr. MacDonald said the State highway departments have cooperated wholeheartedly in applying these funds together with matching amounts of State funds to defense highways wherever possible.

Access roads to defense areas that are also on the Federal-aid secondary system are being improved, and portions of the Federal-aid System on the strategic system approved by the Secretary of War are being given priority over other work.

Although least in mileage because of limitation of law, access roads to army posts, naval establishments, and industrial production areas are the most important and the most urgently needed to speed the defense program, it was pointed out.

"All forms of transportation are being called on to operate at full capacity during the emergency", Mr. MacDonald said, "and available funds are being expended at critical points to eliminate the most serious bottlenecks."

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